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ABSTRACT

Educational outreach programs of Los Alamos National Laboratory assist rural educators in strengthening science curricula; encourage students to take science, math, and English courses; and create a good neighbor policy between the laboratory and rural communities/schools in predominantly Hispanic/American Indian northern New Mexico. The program, initiated in 1981, boosts technical competency of rural students to fulfill the laboratory's employment needs and helps regional economy. Laboratory scientific, technical, and support personnel conduct six types of outreach programs. Science Beginnings for grades 4-6 introduces science-related subjects to stimulate imagination. Programs for high school juniors/seniors include credit courses on state-of-the-art technology, summer programs during which students develop/present science projects with a laboratory mentor, and annual open house for students to talk with scientists about careers and research. A summer institute for secondary school science teachers offers graduate credit. Careers in Science uses panel presentations in regional schools to encourage students in grades 7-10 to consider scientific/technical careers. Panels include people with ethnic backgrounds similar to the target community, males, and females representing jobs which require a variety of educational levels. Background information about the laboratory and region, comments of panel members and teachers, and results of a program evaluation are included. (LFL)

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Paper presented at National Rural and
Small Schools Consortium,
Bellingham, Washington, 1986

MOUNTAIN ROADS, LONELY MESAS:
A CAREER PROGRAM FOR NORTHERN NEW MEXICO

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INTRODUCTION

For more than a hundred years Hispanics, Native Americans, and Anglo-Americans have lived together in the mountains and the Rio Grande Valley of northern New Mexico. In the midst of this tricultural setting stands Los Alamos National Laboratory, a renowned repository of scientific and technical knowledge.

In the counties surrounding Los Alamos, the unemployment rate is higher than the national average and the economy lacks vigor, but in Los Alamos the situation is quite the reverse. In this unique environment, the Laboratory, in the forefront of scientific research, employs technicians, engineers, and scientists from diverse cultural backgrounds. Since 1981, the Laboratory's Community Relations Office has endeavored to create a good neighbor policy between the Laboratory and the communities and schools in northern New Mexico. Educational Outreach has been initiated to boost the technical competency of students from these rural school districts, not only to fulfill the Laboratory's employment needs, but to help the economy of neighboring communities. These educational programs reflect recommendations suggested by current research on encouraging students to pursue technical careers.

This paper is intended to describe one of the educational outreach programs, Careers in Science, and provides a detailed description of the program design, implementation and evaluation. To provide sufficient background, the paper begins with a description of Los Alamos National

Laboratory and its mission, a discussion of the communities surrounding the Laboratory, and a brief description of the other educational programs.

LOS ALAMOS NATIONAL LABORATORY

Los Alamos is a newcomer to northern New Mexico. Established in 1943, its mission was to design a weapon to bring an end to World War II. The atomic bomb fulfilled this role. With it came a new era.

While some proposed Los Alamos be abandoned at the end of the war, new political developments in the world made it apparent that Los Alamos should become a permanent institution. Nuclear research was continued, but as the years progressed, other technical research was recognized as necessary for our country's defense and economy. The Laboratory diversified and expanded. Today there are 33 technical areas over 43 square miles. Eight thousand employees work in over a thousand buildings doing scientific research in the areas that concern our nation today: defense, energy, health and environment.

The majority of research done at Los Alamos is in physics. Neutral-particle beams and free-electron lasers are being studied for application with the strategic defense initiative. Treaty regulations are monitored through sensing instruments on Vela satellites and underground in order to detect nuclear explosions. New materials are developed that will resist high temperatures in order to prevent missiles from overheating.

While many energy programs no longer stand as a national priority, several projects continue to be supported. In the ancient volcanic beds of the adjacent Jemez Mountains, holes have been drilled 3 miles deep in order to convert the internal energy stored in hot dry rock into electricity. At underground temperatures of over 530°F, this geothermal system will produce 10 megawatts of power, enough to handle the needs of a community of 5,000 or 6,000. Once economically efficient, many rural communities may have a clean local source of power.

The internal workings of the atom are also studied. On one of the narrow mesas extending from the Jemez Mountains stands an accelerator 1/2 mile long. The pure science of mesons has delivered many practical applications including a simple cost-effective cure for cancer-eye in cattle.

Irrigation deposits salt and minerals on fields rendering them useless for many kinds of crops. Biologists are studying ways to induce the properties of salt weed into a variety of other grasses. If wheat, for example, could be made salt-resistant, it could be instantly cloned into millions of plants.

Assisting these and hundreds of other projects is a network of computers including 6 Crays, 4 CDC 7600's and 3 CDC 6000 series machines. With over 3500 users, Los Alamos has one of the most powerful scientific computing facilities in the world.

In order to maintain its reputation as a leader in state-of-the-art research and techniques, the Laboratory needs to employ well-trained and highly competent people. Around 3200 of the 8000 employees are staff members, people who have advanced degrees in science or engineering.

Although New Mexicans are actively recruited for these positions, the majority are filled from other states. The ratio of New Mexicans is higher for the less skilled non-staff positions. These also pay the lowest salaries. Nevertheless even many of these positions are filled from out of state. Although New Mexicans have provided a consistently stable workforce for the Laboratory, many northern New Mexicans lack the prerequisite skills, knowledge and experience necessary even for technician level jobs. Thus hundreds of people in neighboring counties are unemployed or greatly underemployed.

NORTHERN NEW MEXICO

Historically the needs and demands of the culture of northern New Mexico have been in contrast to the needs and demands of Los Alamos National Laboratory. This agrarian society has several components. Nineteen pueblos are scattered along the Rio Grande and its tributaries. In 1598 Onate established the first western Spanish colony 20 miles north of Los Alamos. Small Hispanic farming villages clustered around the parent colony, taking advantage of the run off from the rains and snows which accumulates on the nearby peaks. Over the years the perimeter expanded to a 100 mile radius. Further west the Navaho and Apache were later settled on reservations. To the east ranching communities dotted the plains. Today northern New Mexico still reflects this predominantly rural society, a checkerboard of different cultures.

Most of these communities evolved around a rural farming economy. While this agrarian life style has never provided the luxuries associated with prosperity, the income was adequate and secure. All of man's basic needs were provided for: food, shelter, and clothing. However as the population increased and the economy changed, the land could no longer support everyone. Hispanic family holdings were equally divided among the children. Plots have diminished in size, sometimes becoming so small that a house could not be built, much less support a family. This problem is compounded by the fact that much of the land is controlled by the government. In Rio Arriba, a county adjacent to Los Alamos, only 1651 square miles of 3883 square miles is privately owned. On top of this corporations are constantly buying up acreage for recreational development.

Younger people exposed to the media and other cultures can no longer support their desires with an agrarian life style. Even if they want to farm, land has become too expensive, making it almost impossible to increase the size of their sub-divided holdings. Steady flight from rural areas has caused problems for youth not adequately trained for urban employment. Whereas statewide unemployment figures are high at 9.7%, in the neighboring county of Rio Arriba, with a population of 82.2% Hispanic and 10.9% Indian, the unemployment is as high as 18%. Tourism has created 5000 jobs in the area, most of which are in Santa Fe county, but pay averages $7,700 annually.[1] The highest salaries are those in the technical arena where average salaries are $20,000. Yet there is

persuasive evidence that many students, particularly women and minorities, are not aware of the career opportunities in these areas.

Students in northern New Mexico do not always take the basic courses necessary to enter technical fields. A survey in Albuquerque showed that 95% of all students take biology while only 35% go on to chemistry and less than 7% continue in physics. These figures are even more discouraging in rural schools, especially since many do not even offer a physics class. This is in inverse proportion to the needs of the Laboratory and other technical employers where physics is the base of most of the sciences and technical skills.

New Mexico is not alone with the problem of science and math education. According to a recent report 61% of the American students were enrolled in general science in 1969 in contrast to only 37% in 1981. Algebra I enrollments fell to 64% in 1981 from 76% in 1969. Conversely, student enrollment in driver education sky rocketed to 59% in 1981 from a mere 0.3% in 1969. [2]

Another survey shows that less than 33% of our nation's high schools require more than one year of science and math while 75% require more than one year of English and Social Studies.[3] General science curricula also are weak, especially in elementary and middle schools. Electrical and mechanical functions have minimal mention although they have revolutionized our society and directly affect the lives of all Americans. Instead volcanoes, dinosaurs and leaves dominate the content of middle school science classes.

EDUCATIONAL OUTREACH PROGRAMS

In order to assist educators in strengthening science curricula and to encourage students to take the science, math, and English necessary to keep their career options open, the Laboratory has initated a series of educational outreach programs. Starting in 1981, the program now has six on-going components. Each year these programs reach over 10,000 students in grades 4-12. More than 1,000 Laboratory volunteers help to make this possible.

Science Beginnings:

Created for students in grades 4-6, the program introduces science-related subjects to stimulate a child's imagination. Teachers can select from a menu of topics which are delivered by Community Relations Office staff. This program also includes a series of workshops designed to encourage teachers to utilize more demonstrations and experiments in their classrooms. This year a Starlab, an inflatable dome that can be used as a planetarium, has been incorporated into the program.

To supplement Science Beginnings, each year 10-12 schools are invited to bring their 6th grade students to the Laboratory's Bradbury Science Museum on Monday morning to hear presentations by Laboratory personnel. Topics include nuclear energy, zero gravity, lasers, and cryogenics. The visits are also complemented with a teacher's workshop for the participating school staff.

Careers in Science:

This program is aimed for grades 7-10 and is based on research that suggests students at this age are receptive to role modeling. Laboratory employees from a variety of fields volunteer to talk to students about their jobs and the courses needed in high school by students interested in pursuing similar careers. In-depth information about this program is discussed later on in this paper.

Los Alamos Science Student Program (LASSP):

LASSP offers courses to juniors and seniors from 7 area high schools. This program augments the regular school curriculum by providing knowledge and hands-on experience with state of the art technology that is not available in the local schools. Each semester 50-100 students take classes offered for high school credit twice a week from 4:00 - 6:00 p.m. Course offerings taught by Laboratory volunteers have included microbiology, electronics, Fortran, construction contracting, and technical writing. The schools support this program by providing transportation for the students to and from the Laboratory.

Los Alamos Summer Science Student Program:

This is an intensive six-week summer program in which science and technically-oriented high school seniors individually develop, complete and present a science project with the help of a Laboratory volunteer who

serves as a mentor. The selected 20-25 participants also attend morning sessions that consist of seminars, lectures, and tours of Laboratory sites. The program not only enhances the students' backgrounds, but helps them to be more competitive with students from larger and wealthier schools once they enter a university.

Science Youth Days:

For 28 years, the Los Alamos National Laboratory has participated in the international "Edison Days" program. Six to eight hundred high school seniors with aptitudes for science and mathematics come from Arizona, Colorado, Texas, California and New Mexico for a tour of Laboratory facilities. Students are given ample opportunity to talk with scientists about their careers and research projects.

Los Alamos Summer Science Teachers Institute:

In 1984, this institute was established to help northern New Mexico secondary teachers obtain enrichment for their classes by providing them with state-of-the-art techniques and knowledge. This 4 week graduate course offers lectures and tours from Laboratory volunteers and has approved graduate credit from a local university. Two follow-up workshops are also held to extend and reinforce the learning experience. The content of the Institute changes each year and to date has included chemistry, computer science and physics.

CAREERS IN SCIENCE

While efforts have been made to reverse traditional roles among women and minorities, science and technical occupations are seldom introduced as career options until it is too late. One survey shows that Hispanic 17 year-olds scored significantly lower than their white counterparts on the national mathematics assessment in 1982. The national norm was 60.2%. White students scored 63.17% and Hispanics scored 49.4%. The commission found that when Hispanics are exposed to a good learning environment, these students perform as well as any. Low achievement norms reflect a lack of preparation and early exposure to mathematical and scientific concepts, processes critical to later achievement.[4]

Students who stopped taking science and math beyond 10th grade essentially eliminate themselves from technical occupations. Thus students need to be identified as interested in technical careers at a younger age so that they can be guided into a more rigorous schedule in science, math, and English in high school.

While career interest surveys may help identify these students, they are seldom given in middle schools. They are expensive and time consuming, taking away money and classroom time from science departments. Nor are most tests modified for the limited experiences of the junior high school student. While new tests have been developed,[5] they are not consistently being administered. What other methods can be applied in order to encourage students to take the high school courses that will keep their career options open?

A growing body of research suggests that students at this age are particularly receptive to role models. Thomas (1985) reports on previous research. His findings conclude that interaction with professional role models in the natural and technical sciences are critical for recruiting and retaining students' interest in math and science.[6] Students need to understand that if they wish to pursue science as a career, they must take the correct prerequisites. Interest in math and science in high school is a critical determinant of whether a student will actually pursue and persist in these fields. In order for students to maintain an interest in science they must: perceive math and science as fun; identify with scientists; feel that science is relevant to their culture; and feel self-confident in learning science.[7]

The literature also suggests there are several major barriers to students' decisions to pursue science related careers: lack of knowledge about technical careers, lack of knowledge about high school prerequisites, no understanding about what it is like "on the job", lack of encouragement from family and teachers, lack of role models, and lack of positive attitudes toward science.[8]

Most small rural communities in New Mexico have few if any role models working in technical fields. For students to meet with scientists, engineers, computer programmers and technicians, they must have people come from other communities where technical people are employed. In northern New Mexico, the largest such employer is Los Alamos National

Laboratory. In fact 38% of the jobs in north-central New Mexico are directly or indirectly supported by the Laboratory.[9] Yet nationwide less than one out of 10,000 Hispanics and Indians choose technical careers.[10]

Careers in Science was initiated in February, 1981 to encourage young people in grades 7-10 to consider technical careers. Since then almost 30,000 students have received some technical career guidance. Most of these students are in rural school districts that cover a large territory. The core territory consists of seven counties, an area which equals the combined states of Massachusetts, Connecticut and New Jersey. However, additional programs are given to schools in Zuni and on the Navaho Reservation where distances exceed 250 miles in one direction. The region is remote with gas stations sometimes over 100 miles apart.

The program consists of a panel of 4-5 volunteers, but depending on format and time, the size can vary from three to seven. The program, with support from the Laboratory upper managemement, draws on any of the 8000 Laboratory personnel for its volunteers. Since role modeling is a prime concern, care is taken to include one or two people indigenous to the community visited, or at least people with a similar ethnic background. The male and female panel members also represent jobs which require a variety of educational levels from technician to scientist. Support personnel, such as secretaries, technical writers and photographers, are also included as speakers. The make-up of the panel changes with each school. No volunteer is asked to participate more than once or twice a year. Last year 129 people took part and over the years almost 300

speakers have participated. By now many of the panel members are veterans to the program, but no one is eliminated because of inexperience. If panel volunteers have never spoken to a school group, they are counseled by the moderator and experienced panel members on how to set up an appealing talk and demonstration. Some groups at the Laboratory have made up special kits in order to provide interesting demonstrations for volunteer group members to take to the schools.

Speakers are given 10-15 minutes for their presentation, and focus on one aspect of the overall message. Some, especially those from the community, talk about themselves, "If I can do it, so can you." Others talk about a specific research project they are working on, e.g. how an experiment is designed to go on the space shuttle. Others talk about careers, such as the opportunities and steps necessary to enter these professions. Finally some talk about day-to-day life at the Laboratory, e.g. the typical kinds of problems one solves as an electronic technician assigned to trouble shoot computer systems. All speakers emphasize courses necessary in high school to pursue a similar career. Because a major goal of the program is to motivate an interest in science, panel members are encouraged to include demonstrations. They may be simple--showing how a weather balloon is packaged or radiation detected, or dramatic--showing the difference between an explosion and detonation or the effects of liquid nitrogen on every day objects.

After panel members have completed their presentations, the moderator introduces the hands-on, question and answer session. Depending on the school schedule, the hands-on portion of the program lasts 10-60

minutes. Panel members bring equipment from their jobs such as computers, robots, lasers, thermo couples, vibrating machines, etc. in order to encourage students to participate.

The program is designed for students in 7th to 10th grades but often schools are so small that the entire student body constitutes the program audience. Programs are scheduled on a first-come, first-serve basis with schools from the Laboratory's target seven county area. Exceptions beyond this area are made but must be approved by the Community Relations Officer. If the drive is over 2 hours, 2 or 3 schools are scheduled back-to-back for an overnight trip. Examples of some of the communities visited:

Dulce - The major settlement on the Jicarilla Apache reservation is about 130 miles from Los Alamos. Other than a general store, the closest shopping of consequence is in Farmington, 100 miles from Dulce. Unemployment is very high with agriculture, basically stock, as the main source of employment. There is some tourism, gas field drilling, and roadwork. Last year the tribe funded a new school with two equipped laboratories and three lecture halls. In the past couple of years there has been an increase in science offerings. Chemistry and computer science are now included.

Lybrook- This school is 150 miles northwest of Los Alamos in an isolated location on the Navajo Reservation. Some students travel 2 hours on dirt roads to attend classes which are held in portable trailers. The school terminates at grade 8 and feeds into a high school that is another 80 miles away. The economy is generally depressed because of the decline in the oil industry. Herding and "arts and crafts" are the main occupations.

Ojo Caliente- Approximately 50 miles from Los Alamos, the school consolidates the Hispanic population from several very small subsistance farming communities. There is little other employment although this area is within commuting distance from the Laboratory.

Questa- A basically Hispanic community, Questa is located 70 miles northeast of Los Alamos. Its economy was based on molybdenum until last winter when the mine shut down. The Laboratory has endeavored to set up a special employment initiative to absorb some of the large numbers of people left suddenly unemployed. Until then the school system had been reasonably stable with a gradual increase in science offerings. They are now working on building up their physics curriculum.

A typical day for the Careers in Science program starts around 7:00 a.m. Panel members usually have not met each other before. After introductions the panel sets out for the school. Because cultural backgrounds in the panel are mixed, interesting conversations develop promoting a better understanding of values among Laboratory employees.

Once at the school, the panel gives 2 to 4 presentations, each lasting one or two hours. While schools are asked not to have audiences that exceed 50, extra classes sometimes are squeezed in so that groups exceed 100. In spite of hot crowded conditions where students sometimes must stand for the entire program, discipline has not been a problem. Instead, one of the major problems of the program is getting one group out so the next one can begin. Other problems usually deal with logistics; carrying extra extension cords, A.V. equipment etc., eliminates many of them.

If panel members are nervous before they begin, they are enthusiastic by the end of the day. One problem is scheduling the volunteers so that each one has a turn at a school. There are so many anxious to participate, scheduling is almost on an every other year basis.

Typical comments from panel members include:

> "...It is very wise for the scientific community to give this type of display to high school students...I remember well not having any plans after graduation until a demonstration at school. I owe my decision to go to college to that demonstration."

"I became involved in this program when I discovered some technicians graduating from this area had graduated from high school without taking algebra. I am not from this state and felt young people needed more exposure."

"I got a new respect for teachers. Also a new respect for my job which I love and a better understanding of what kids are going through these days."

"With all of the questions I received from the students, I felt they were encouraged to continue their education."

Faculty response has been very favorable. The program contact varies from school to school, but mostly include counselors, science, math, or English teachers.

Some typical teacher comments are:

"Since the program was started here 3 years ago, I have noticed more people thinking about careers. It motivates not only the fast, but those that may be giving up a little."

"This gets kids more interested in their science classes. They were able to see positive role models. Since both presenters are Native American, it gives the kids a sense of pride."

> "The biggest benefit is the notion that 'you' can accomplish the types of things professionals have but they require work, dedication and perseverance. It was implicitly clear to them that success does not come cheaply. You reinforce the concept 'Stay in school and study hard,' which these kids need to hear over and over. The presentations and 'hands-on' got students more involved than I've seen in some time."

In the spring of 1985 an outside consultant conducted a formal evaluation of the "Careers in Science" program. To enhance the reliability and validity of the data, data collection was triangulated. A questionnaire was mailed to 130 educators, basically principals and staff in the science, math and counseling departments. Twenty-three telephone interviews were conducted with a random sample of Laboratory employees who were recruited as role models. The program was also observed to get a first-hand view of the operation, student reaction and teacher affect.

A summary of the findings from the evaluation demonstrates that the program:

- reaches a broad audience
- provides information about technical career possibilities
- encourages students to maintain an interest in math, science and english
- provides appropriate role models

- o presents career-related demonstrations and opportunities for hands-on experiences
- o discusses what it's like "on-the-job" in a science career
- o attempts to motivate students to prepare for college or vo-tech
- o provides enrichment to classroom instruction
- o provides exposure to state-of-the-art science at Los Alamos National Laboratory
- o provides a positive image of the Laboratory in northern New Mexico by:
  - generating goodwill in the communities
  - "demystifying" Los Alamos
  - encouraging identification with panel members
- o Provides a source of employee pride by giving panel members an opportunity to contribute to shaping students' futures; gives them formal recognition of the importance of their job.

The evaluation also came up with several recommendations to increase the impact of the program. It was suggested that a few schools be selected for a "target" program. Instead of one visit during the school year, a small target group of students would have two or three repeated visits. This would not only increase their spectrum of career information, but would reinforce the goals of the program. It was also suggested that the "target" program enlist more assistance from the

faculty for this reinforcement. Studies show that after parents, teachers have the most influence on a students' career selection.[11]

The recommendations were implemented in the following way. The on-going "Careers in Science" program was to continue at the majority of schools previously serviced. In addition, ten schools were selected for the "target" program. A meeting was arranged with the principal and school contact. If the school expressed interest in the expanded program, and all of them did, they were then requested to set dates for the programs, select a target group of students for the repeated visits, and to arrange a time when a panel could meet with the faculty in order to discuss technical careers.

The first presentation to each "target" school consisted of a career panel. The schools were then given a menu in order to select other programs. For example, some schools wanted extra asisstance on science fair projects for their students. The assistance provided included a science fair judge who discussed how he assessed originality, a technical writer who worked with individual students on their abstracts, and a expert on statistics who helped organize data collection.

Other schools opted for more activities. Several schools arranged for a hike with a geologist and botanist; some wanted topical speakers such as an astronomer to discuss Halley's Coment. At some point during their visit, these volunteers would also discuss their careers with the "target" group of students.

The "target" program is still in its pilot stage but initial feedback has been very positive. Teachers not only liked the reinforcement the "target" program has had with some of their students, but have enjoyed the variety of assistance the program has provided. The workshop with faculty members also allowed for interactions among Laboratory personnel and teachers who are not normally exposed to the program. This extra teacher contact took place the same day as the first program, introducing staff not only to technical careers but to the "target" program.

CONCLUSION

Response to the Laboratory's educational outreach program has been extraordinary. Community media reports and feedback from students, parents, and teachers evidence overwhelming positive support. Formal program evaluations have established that the "Careers in Science" and other outreach programs increase public understanding of current scientific research and the need for a strong science program. Students have been encouraged to consider careers in science and technology. Laboratory volunteers are equally enthusiastic about continuing these programs which enrich the education curriculum in the rural sections of northern New Mexico. In years to come, we also expect the Community Relations educational outreach programs will enable the Laboratory to rely upon northern New Mexico as an ever-growing resource for new scientists, engineers and technicians.

In a continual clarification of Laboratory values, our director Dr. Siegfried Hecker has written, "The Laboratory is the largest employer in northern New Mexico. This carries with it a responsibility to be a good neighbor. A good neighbor who not only offers employment and procurement possibilities, but also one who conducts his business in a safe, secure, and environmentally acceptable manner." The Community Relations Office developed the educational outreach programs in order to meet the challenge of being a good neighbor and to help the educational systems in the small rural communities that surround it.

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